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Non-LTE analysis of the formation of EuII lines in the atmospheres of solar-type stars

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Abstract

A method to analyze the statistical equilibrium of the EuII ion based on a 36-level model atom has been developed. The formation of EuII lines without assuming local thermodynamic equilibrium (LTE) is considered for Teff = 5500-7000 K, logg = 4.0, and metallicities [A] from 0 to -1.5. Non-LTE effects in the level populations are primarily due to radiative pumping of excited states from the ground and low-lying levels, which leads to over-population of upper relative to lower levels. As a result, the studied λ4129 and λ6645 Å lines are weaker than in the LTE case. However, due to the small energy differences between even low-lying EuII levels, collisional coupling is strong, and deviations from LTE in EuII lines are modest: for the Sun, non-LTE corrections to the abundance are only 0.04 dex. The non-LTE effects grow with an increase in the effective temperature and with a decrease in the metallicity, so that non-LTE abundance corrections can reach 0.12 dex for Teff = 5500K, logg = 4.0, [A] = -1.5 and 0.1 dex for Teff = 7000K, logg = 4.0, [A] = 0. The effect of inaccuracy in the atomic parameters for EuII on the non-LTE calculations is examined. Analysis of the profiles of the solar EuII λ4129 and λ6645 Å lines is used to empirically refine estimates of the efficiency of collisional processes in forbidden transitions in establishing the distribution of EuII ions over excited states.